THE SYMBOLS OF THE CHEMICAL ELEMENTS

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The names of the chemical elements have received a certain amount of attention in Word Ways over the years. The very first issue of Word Ways in February 1968 presented a quiz on 20 transposed element names. Later articles have offered more extensive transpositions, trnsadditions, old names for some of the elements, elements in US placenames, and words composed solely of the element symbols, such as CoAgULaTe.

In this article, I want to examine the symbols of the chemical elements as an ordered collection of letters. Many earlier items in Word Ways have treated the typewriter (computer) keyboard as an ordered sequence of letters (QWERTYUIOPASDFGHJKLZXCVBNM) and have posed questions such as:

- What is the longest word with its letters spelled in keyboard order?
- What is the longest word with its letter spelled in reverse keyboard order?
- What is the longest word with letters from the first letter row?

Similar questions can be raised with regard to the elemental symbols. First off, let's take a look at the periodic table, the listing of chemical elements in atomic number order and the corresponding symbols. The list below contains 109 elements, with atomic numbers from 1 to 109. For three of the elements (aluminum, sulfur, cesium) there exist variant British spellings (aluminium, sulphur, caesium). For elements 104 to 109 I have used the new provisional names rather than the earlier suggested names. My 1998 printing of the Merriam-Webster Collegiate Dictionary, 10th edition, lists three new names for elements 104, 105 and 109; my 1995 edition of The Concise Oxford Dictionary lists the new names for elements 104-108; and my 1998 edition of The Chambers Dictionary has the new names for elements 104-107 and 109 (but not 108). Putting these three sources together gives me the new names for all the elements 104-109.

The atomic numbers (1-109), the symbols of the chemical elements and their names are given in the list below. This is the raw material for the remainder of this article.

1-5 H hydrogen He helium Li lithium Be beryllium B boron
6-10 C carbon N nitrogen O oxygen F fluorine Ne neon
11-15 Na sodium Mg magnesium Al aluminum Si silicon P phosphorus
16-20 S sulfur Cl chlorine Ar argon K potassium Ca calcium
21-25 Sc scandium Ti titanium V vanadium Cr chromium Mn manganese
26-30 Fe iron Co cobalt Ni nickel Cu copper Zn zinc
31-35 Ga gallium Ge germanium As arsenic Se selenium Br bromine
36-40 Kr krypton Rb rubidium Sr strontium Y yttrium Zr zirconium
41-45 Nb niobium Mo molybdenum Tc technetium Ru ruthenium Rh rhodium
46-50 Pd palladium Ag silver Cd cadmium In indium Sn tin
51-55 Sb antimony Te tellurium I iodine Xe xenon Cs cesium
56-60 Ba barium La lanthanum Ce cerium Pr praseodymium Nd neodymium
61-65 Pm promethium Sm samarium Eu europium Gd gadolinium Tb terbium

66-70 Dy dysprosium Ho holmium Er erbium Tm thulium Yb ytterbium
71-75 Lu lutetium Hf hafnium Ta tantalum W tungsten Re rhenium
76-80 Os osmium Ir iridium Pt platinum Au gold Hg mercury
81-85 Tl thallium Pb lead Bi bismuth Po polonium At astatine
86-90 Rn radon Fr francium Ra radium Ac actinium Th thorium
91-95 Pa protactinium U uranium Np neptunium Pu plutonium Am americium
96-100 Cm curium Bk berkelium Cf californium Es einsteinium Fm fermium
101-105 Md mendelevium No nobelium Lr lawrencium Unq unnilquadium Unp unnilpentium
106-109 Unh unnilhexium Uns unnilseptium Uno unniloctium Une unnilennium

We can view the symbols as an ordered sequence of 210 letters.

Question 1: Using the 210-letter sequence, what real words (three letters and longer) are spelled out in order by adjacent letters of the symbols?

As an example, the word SIP is spelled out by the symbol sequence Si, P (atomic numbers 14, 15). The longer SIPS is spelled out by the sequence Si, P, S (atomic numbers 14,15,16). Note that some words use a single letter from a two-letter symbol—for example, the word GALS is spelled out from the sequence Mg, Al, Si (atomic numbers 12,13,14). Some words stretch across three symbols (SIPS, CLARK, CONIC), but there are no examples stretching across four.

The following is a reasonably full list of words that can be spelled out, including a few proper names. I am sure that additional words could be added by including obsolete words from the Oxford English Dictionary and increasingly obscure placenames.

In my opinion, the best word on the list is the five-letter CONIC. There are 47 words in this list. Anyone get it up to 50?

HHeLiBeBCNOFNeNaMgAlSiPSClArKCaScTiVCrMnFeCoNiCuZnGaGeAsSeBrKrRbSrY

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  Eli          nam   sip clark              coni    gag ass
   lib            gal     lar               conic   gage
                  gals    lark                 cuz  age
                     sips  ark
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ZrNbMoTcRuRhPdAgCdInSnSbTeIXeCsBaLaCePrNdPmSmEuGdTbDyHoErTmYbLuHfTaW

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    mot       dag din            bal cep      meu       hoe          taw
       cru        dins            ala                    hoer
                   ins             lac
                                   lace
                                    ace
```

ReOsIrPtAuHgTlPbBiPoAtRnFrRaAcThPaUNpPuAmCmBkCfEsFmMdNoLrUnq

```
   sir tau          poa       act                                  run
                   oat
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UnpUnhUnsUnoUne

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  pun uns noun
     hun
     huns
      unsun
        sun
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Question 2: Using the 210-letter sequence, what sets of adjacent symbols can be transposed to create real words? Within this question, I am looking to use all the letters of the symbols used, rather than just one of two letters (or two of three letters). As an example, the word BIBLE can be generated from the three symbols Li, Be, B (atomic numbers 2,3,4). There are some examples of transposals generated from four symbols (MAGILPS from Mg, Al, Si and P (atomic numbers 12,13,14,15) and DANCINGS from Ag, Cd, In and Sn (atomic numbers 47,48,49,50). There are no examples of five adjacent symbols being transposable to make a real word.

The best word on this list, again in my opinion, is the eight-letter SPORTIER. There are other eight-letter words, but I feel this is the commonest. There are 141 transposals here. What others can be added?

HHeLiBeBCNOFNeNaMgAlSiPSClArKCaScTiVCrMnFeCoNiCuZnGaGeAsSeBrKrRbSrY

heh ebb fon mang pis carl cist cion ages
elhi con Anne ails carls cits coin gaes
heil conf mangal clarks tics icon sage
bile foen glam unci seas
bible fone Glamis caracks basser
fen magilps brases
nef sail sabers
sial sabres
lapis rebs
pails Serb
spail
spial
spails
spials
psi
piss
psis

ZrNbMoTcRuRhPdAgCdInSnSbTeIXeCsBaLaCePrNdPmSmEuGdTbDyHoErTmYb

curt dancings tie bacs emus yodh hatful
inns excites alec meus hero haft
best cabs muse hore
bets scab degums mother
besit cabals mudges term
bites alba smudge
baal gude
capabler budget
carple
craple
parcel
placer

LuHfTaWReOsIrPtAuHgTlPbBiPoAtRnFrRaAcThPaUNpPuAmCmBkCfEsFmMdNoLrUnq

hatful eros tapu atop raca pun emfs lorn
haft ores galuth parton charta puma fems
wat sori patron chat
tawer ript tarpon tach
water trip rant path

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wrate                    tarn      phat
  rew
  owers
  owres
  resow
  serow
  sower
  swore
  worse
  worries
   roes
   rose
   sore
   rosier
   pierrots
   sportier
     prosit
     ripost
     tripos

UnpUnhUnsUnoUne
pun
   hun
      nus
      sun
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Question 3: If we remove the constraint imposed in Question 2 (using only complete symbols), what transposals can be found from adjacent symbols, that is by allowing one letter from a two-letter symbol, or two letters from a three-letter symbol?

Some words appear in the following list as well as in answer to Question 2. In Question 2, FON appears as a transposal of N, O and F (atomic numbers 7,8,9); FON reappears in the following list as a transposal of O, F and the N of Ne (atomic numbers 8,9,10). Also, CLARK makes a reappearance. In Question 2, CLARK is generated as a transposal of Cl, Ar, K (atomic numbers 17,18,19), but in Question 3, it is generated from {C)l, Ar, K, C(a) (atomic numbers 17,18,19,20). That is, the C in CLARK comes from the C of Ca instead of the C of Cl. Other repeated examples include COIN and its mutual transposals.

Some words appear twice in the following list. For example, RACK appears twice, first as a transposal of Ar, K, C(a), and then as a transposal of (A)r, K, Ca. OSIER and MOTHERY each appear twice for a similar reason.

No words in the response to Question 1 (words formed by the symbol letters in sequence) have been automatically repeated in the following response.

In my opinion, the best words in this list are the nine-letter PRIORATES and the unexpected CATARRH. There are 263 transposals here, counting repeated words. What others can be added? There is such a concentration of words around atomic numbers 75,76,77,78 that I wouldn't be surprised if some fairly obvious words have been missed! Obviously, searching progressively more obscure references will certainly throw up many additional items.

HHeLiBeBCNOFNeNaMgAlSiPSClArKCaScTiVCrMnFeCoNiCuZnGaGeAsSeBrKrRbSrY

lei bonce ane lips clark cit fen ion gan seas
lie fon lisp lark tic nef nag eases
bile ean slip cark confine gang bases
belie nae lisps rack cone gag basse
amen slips cark once gases
mane clips rack cion sages
name spic racks coni baskers
nema claps sack icon Serbs
mange clasp sac berks
agname lacs sac kerbs
manage lac acts berk
gamelan cracks kerb
gamelans cast
cats
scat

ZrNbMoTcRuRhPdAgCdInSnSbTeIXeCsBaLaCePrNdPmSmEuGdTbDyHoErTmYb

mob cur dap nid bents sec palace mems hoy buhl
mot pad nids bite abs cape ems mothery
tom gad sind exit bas pace mes other
cot nis excite cabal geums throe
toc sin excise caple geum mothery
torc sab caper ore
court albs pec roe
curr bals per rote
churr labs pre tore
slab rep metro
albas ret
baals
balas
balsa
basal
capable
carpale
place
crape
pacer
recap
prance

LuHfTaWReOsIrPtAuHgTlPbBiPoAtRnFrRaAcThPaUNpPuAmCmBkCfEsFmMdNoLrUnq

aft osier apt poi arar hap pup efs don
fat prosier hug patio carrat puna amu effs nod
waft oes pat atropin catarrh pupa
wafter sir uta aport carat caum
wart ios tap porta carta cam
raw iso haut tao acta mac
war sri Utah rato chapt
arew pirs aught rota patch
ware rips ghaut taro chapt
wear risp thug orant patch
ower pir toran pah
owre rip trona
wore atrip afront
priorates art
ose aught rat
osier ghaut tar

poiser
posier
periost
poriest
prostie
reposit
riposte
ropiest
 airpost
 airstop
 parotis
 spirt
 sprit
 stirp
 strip
 trips
 partis
 rapist
 tapirs
 upstair
  parti
  tapir
   part
   prat
   rapt
   tarp
   trap
   pruta
   prutah
    taught

UnpUnhUnsUnoUne
 pun shun
    hun onus
       nus
       sun
       nouns

Most words in this article are in Official Scrabble Words, International Edition. A few well-known proper names have been included (ELI, ANNE, UTAH) plus one or two words from the OED and Webster's Second Edition. A thorough search of Webster's Third, the OED and other references is likely to unearth additional items.

This article has concentrated on the symbols for the chemical elements with atomic numbers 1 to 109. A later article will consider the theoretical elements with atomic numbers of 110 and higher.